FIG.1

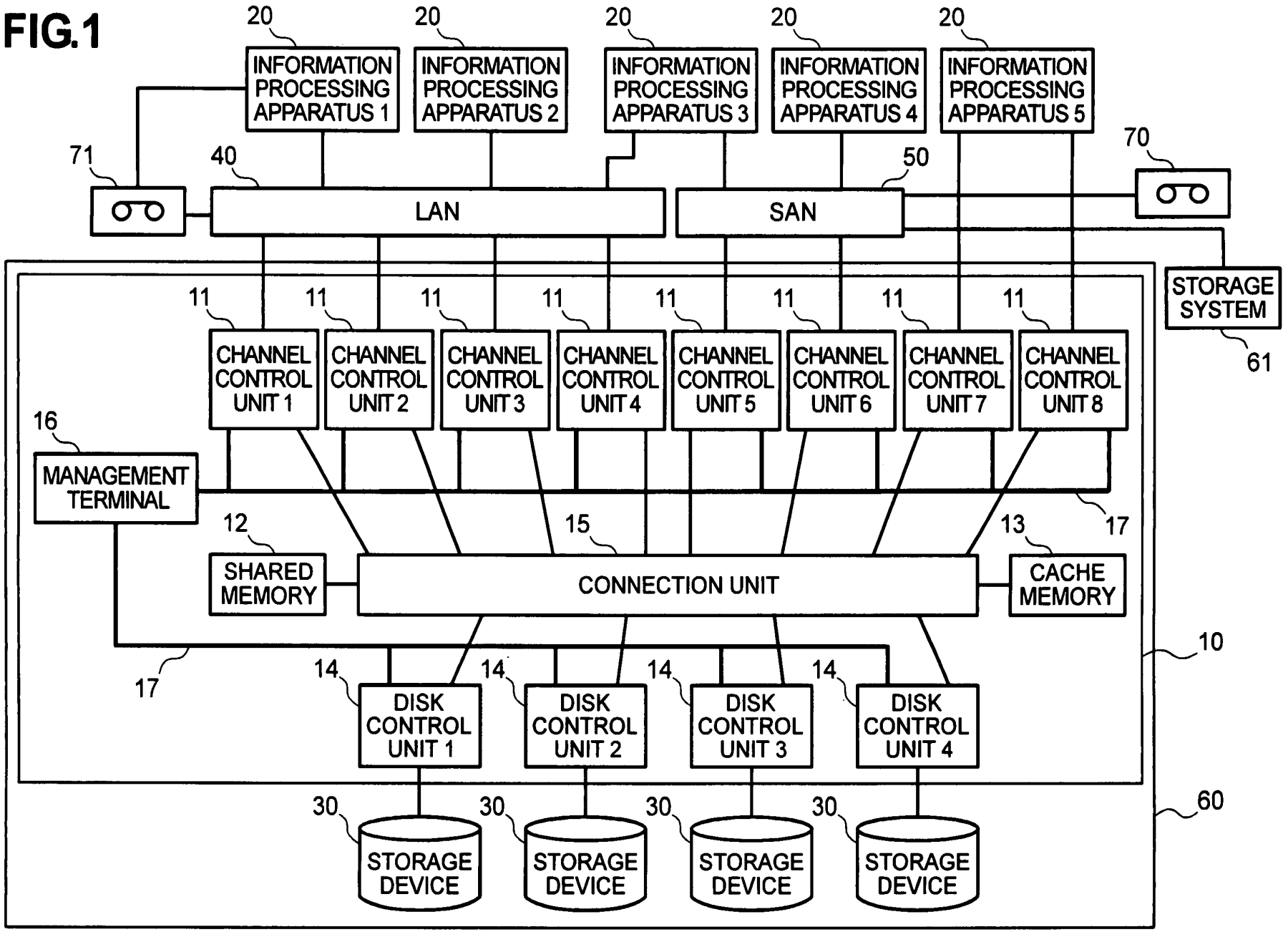

20
INFORMATION PROCESSING APPARATUS 1
20
INFORMATION PROCESSING APPARATUS 2
20
INFORMATION PROCESSING APPARATUS 3
20
INFORMATION PROCESSING APPARATUS 4
20
INFORMATION PROCESSING APPARATUS 5
71
40
LAN
50
SAN
70
STORAGE SYSTEM
61
11
CHANNEL CONTROL UNIT 1
CHANNEL CONTROL UNIT 2
CHANNEL CONTROL UNIT 3
CHANNEL CONTROL UNIT 4
CHANNEL CONTROL UNIT 5
CHANNEL CONTROL UNIT 6
CHANNEL CONTROL UNIT 7
CHANNEL CONTROL UNIT 8
16
MANAGEMENT TERMINAL
12
SHARED MEMORY
15
CONNECTION UNIT
13
CACHE MEMORY
17
17
10
14
DISK CONTROL UNIT 1
DISK CONTROL UNIT 2
DISK CONTROL UNIT 3
DISK CONTROL UNIT 4
30
STORAGE DEVICE
60

FIG.2

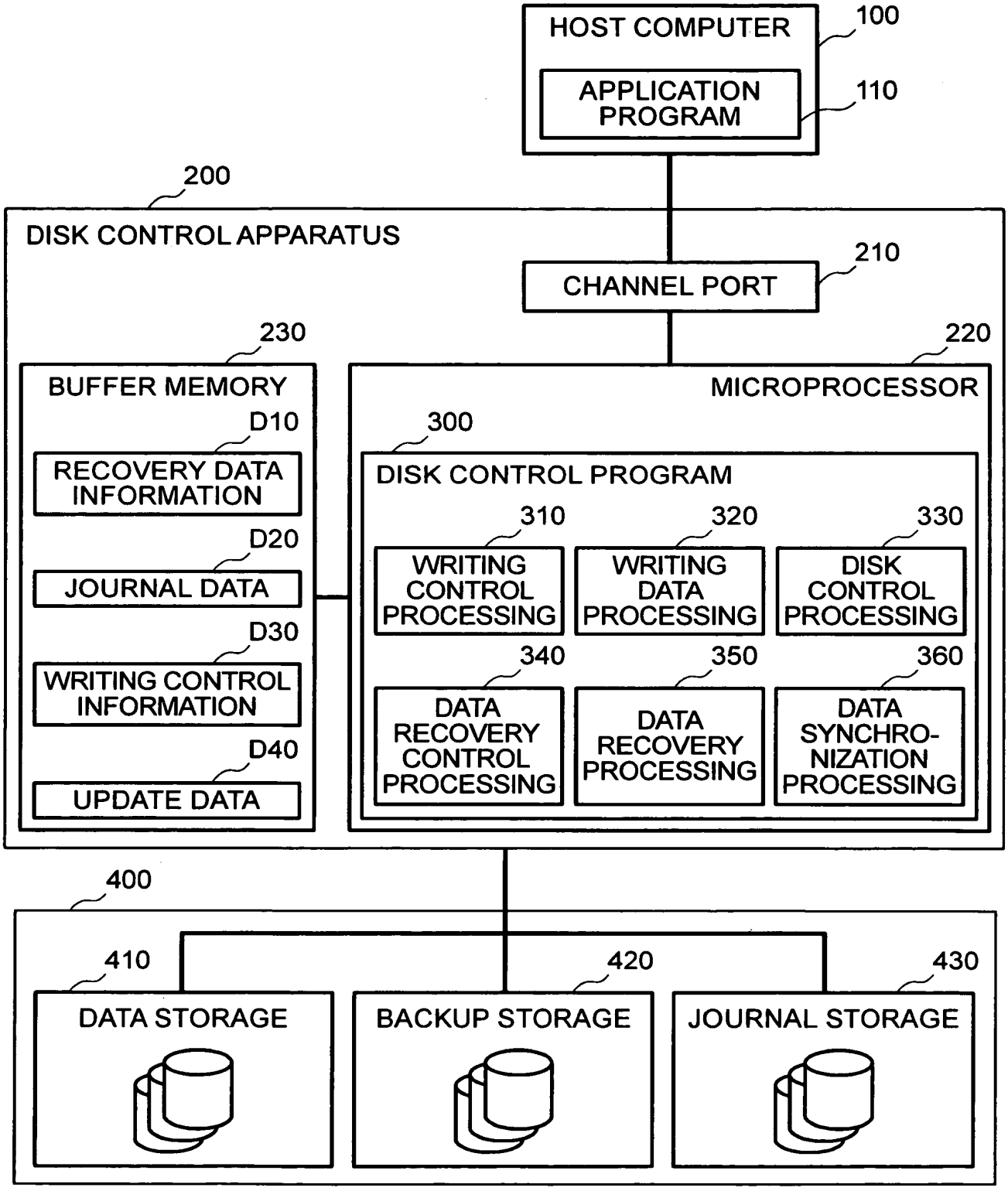

HOST COMPUTER
100
APPLICATION PROGRAM
110
200
DISK CONTROL APPARATUS
210
CHANNEL PORT
230
BUFFER MEMORY
220
MICROPROCESSOR
D10
RECOVERY DATA INFORMATION
300
DISK CONTROL PROGRAM
D20
JOURNAL DATA
310
WRITING CONTROL PROCESSING
320
WRITING DATA PROCESSING
330
DISK CONTROL PROCESSING
D30
WRITING CONTROL INFORMATION
340
DATA RECOVERY CONTROL PROCESSING
350
DATA RECOVERY PROCESSING
360
DATA SYNCHRO-NIZATION PROCESSING
D40
UPDATE DATA
400
410
DATA STORAGE
420
BACKUP STORAGE
430
JOURNAL STORAGE

FIG.3

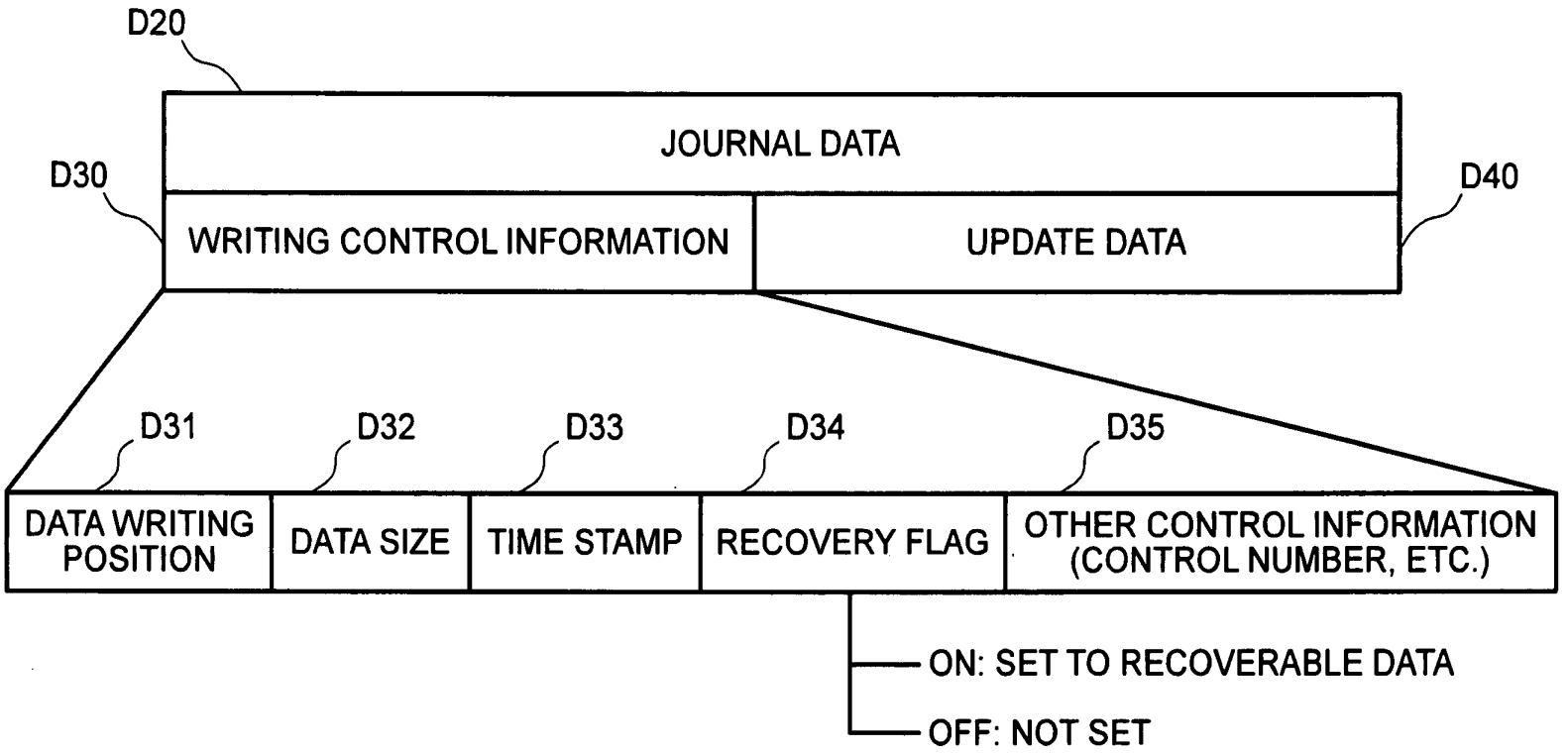

D20
JOURNAL DATA
D30
WRITING CONTROL INFORMATION
UPDATE DATA
D40
D31
D32
D33
D34
D35
DATA WRITING POSITION
DATA SIZE
TIME STAMP
RECOVERY FLAG
OTHER CONTROL INFORMATION (CONTROL NUMBER, ETC.)
ON: SET TO RECOVERABLE DATA
OFF: NOT SET

FIG.4

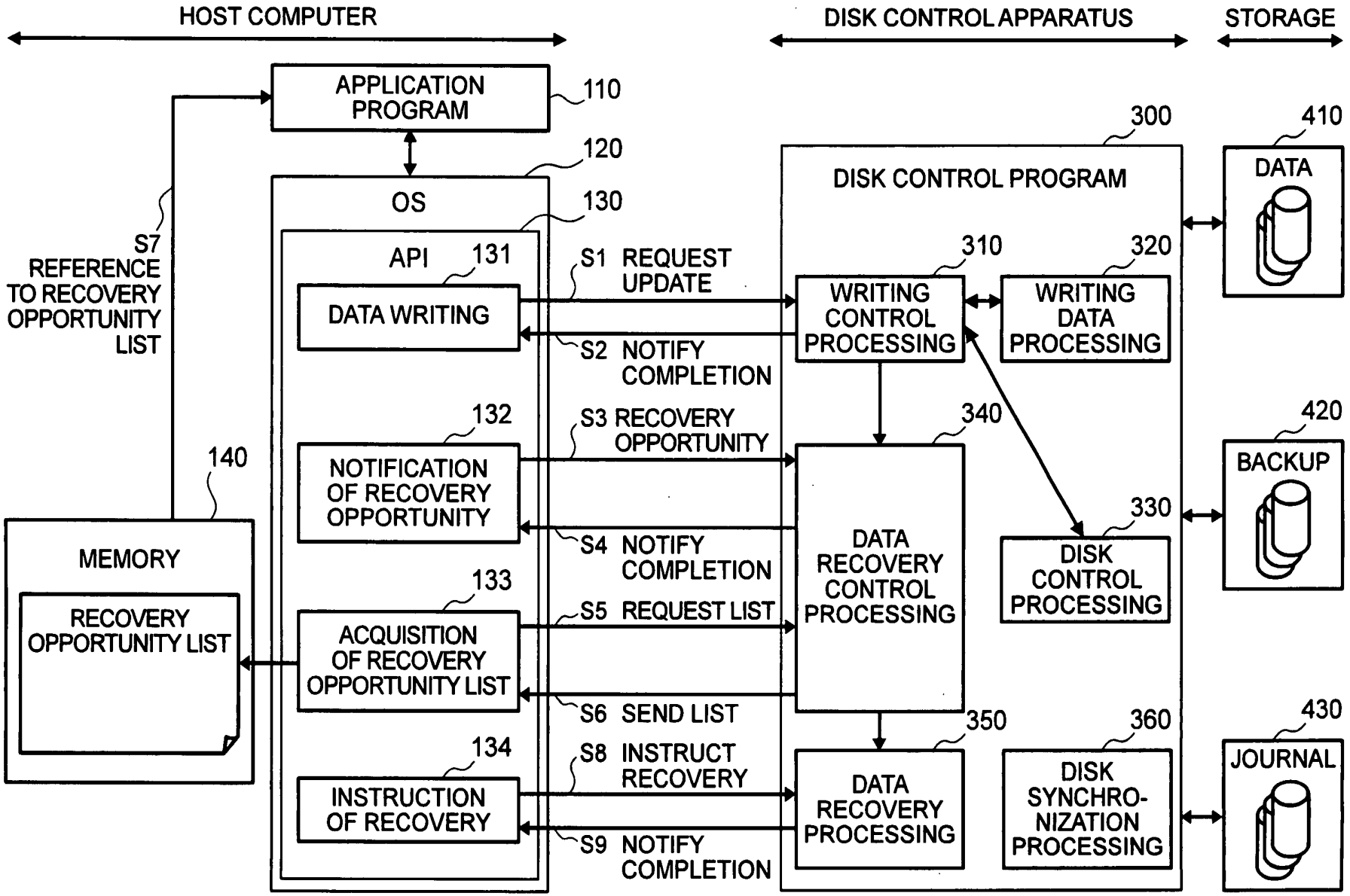

HOST COMPUTER
DISK CONTROL APPARATUS
STORAGE
APPLICATION PROGRAM
110
120
OS
130
API
131
DATA WRITING
132
NOTIFICATION OF RECOVERY OPPORTUNITY
133
ACQUISITION OF RECOVERY OPPORTUNITY LIST
134
INSTRUCTION OF RECOVERY
140
MEMORY
RECOVERY OPPORTUNITY LIST
S7 REFERENCE TO RECOVERY OPPORTUNITY LIST
S1 REQUEST UPDATE
S2 NOTIFY COMPLETION
S3 RECOVERY OPPORTUNITY
S4 NOTIFY COMPLETION
S5 REQUEST LIST
S6 SEND LIST
S8 INSTRUCT RECOVERY
S9 NOTIFY COMPLETION
300
DISK CONTROL PROGRAM
310
WRITING CONTROL PROCESSING
320
WRITING DATA PROCESSING
340
DATA RECOVERY CONTROL PROCESSING
330
DISK CONTROL PROCESSING
350
DATA RECOVERY PROCESSING
360
DISK SYNCHRO-NIZATION PROCESSING
410
DATA
420
BACKUP
430
JOURNAL

FIG.5

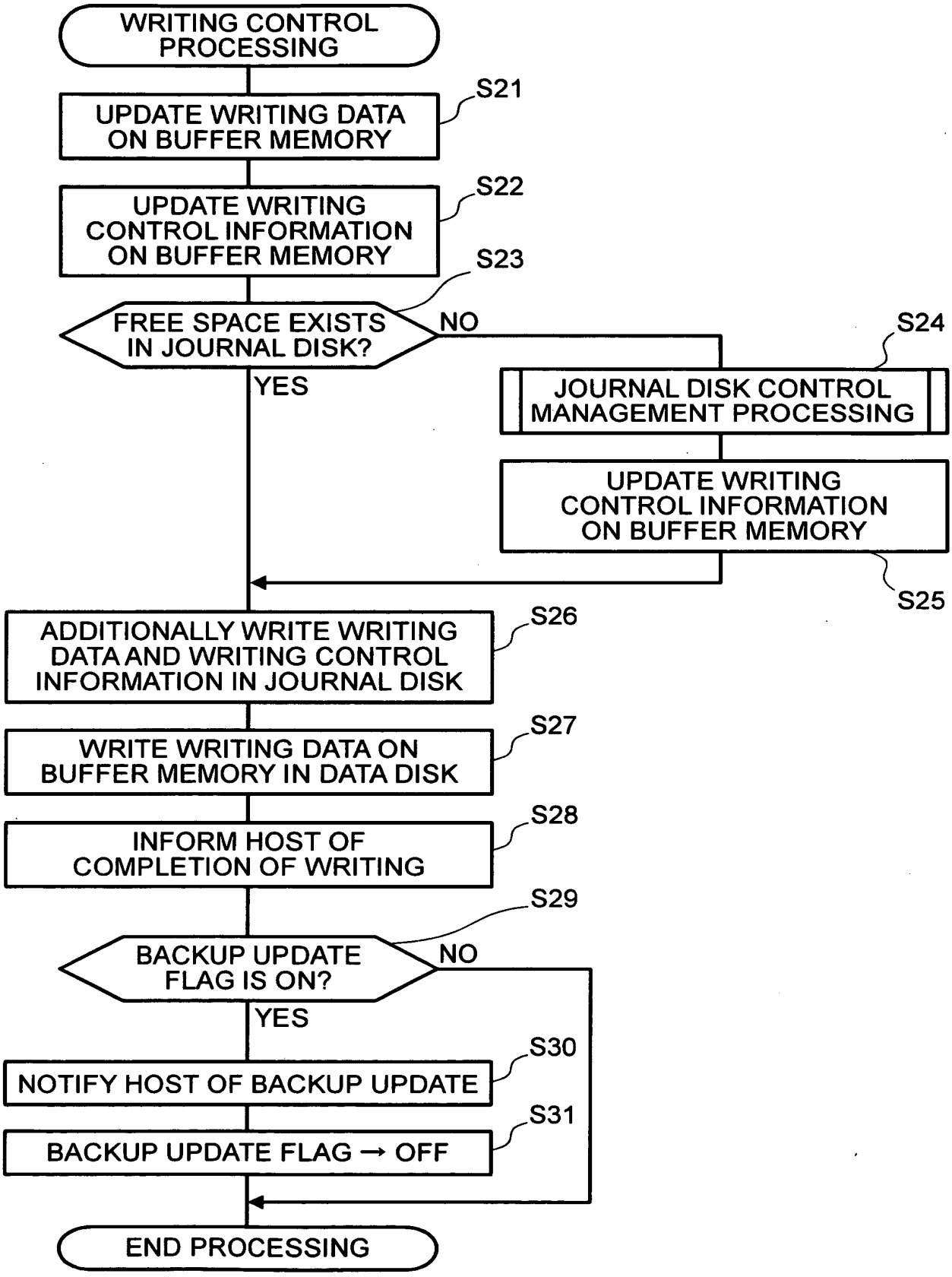

WRITING CONTROL PROCESSING
S21
UPDATE WRITING DATA ON BUFFER MEMORY
S22
UPDATE WRITING CONTROL INFORMATION ON BUFFER MEMORY
S23
FREE SPACE EXISTS IN JOURNAL DISK?
NO
S24
JOURNAL DISK CONTROL MANAGEMENT PROCESSING
UPDATE WRITING CONTROL INFORMATION ON BUFFER MEMORY
S25
YES
S26
ADDITIONALLY WRITE WRITING DATA AND WRITING CONTROL INFORMATION IN JOURNAL DISK
S27
WRITE WRITING DATA ON BUFFER MEMORY IN DATA DISK
S28
INFORM HOST OF COMPLETION OF WRITING
S29
BACKUP UPDATE FLAG IS ON?
NO
YES
S30
NOTIFY HOST OF BACKUP UPDATE
S31
BACKUP UPDATE FLAG → OFF
END PROCESSING

FIG.6

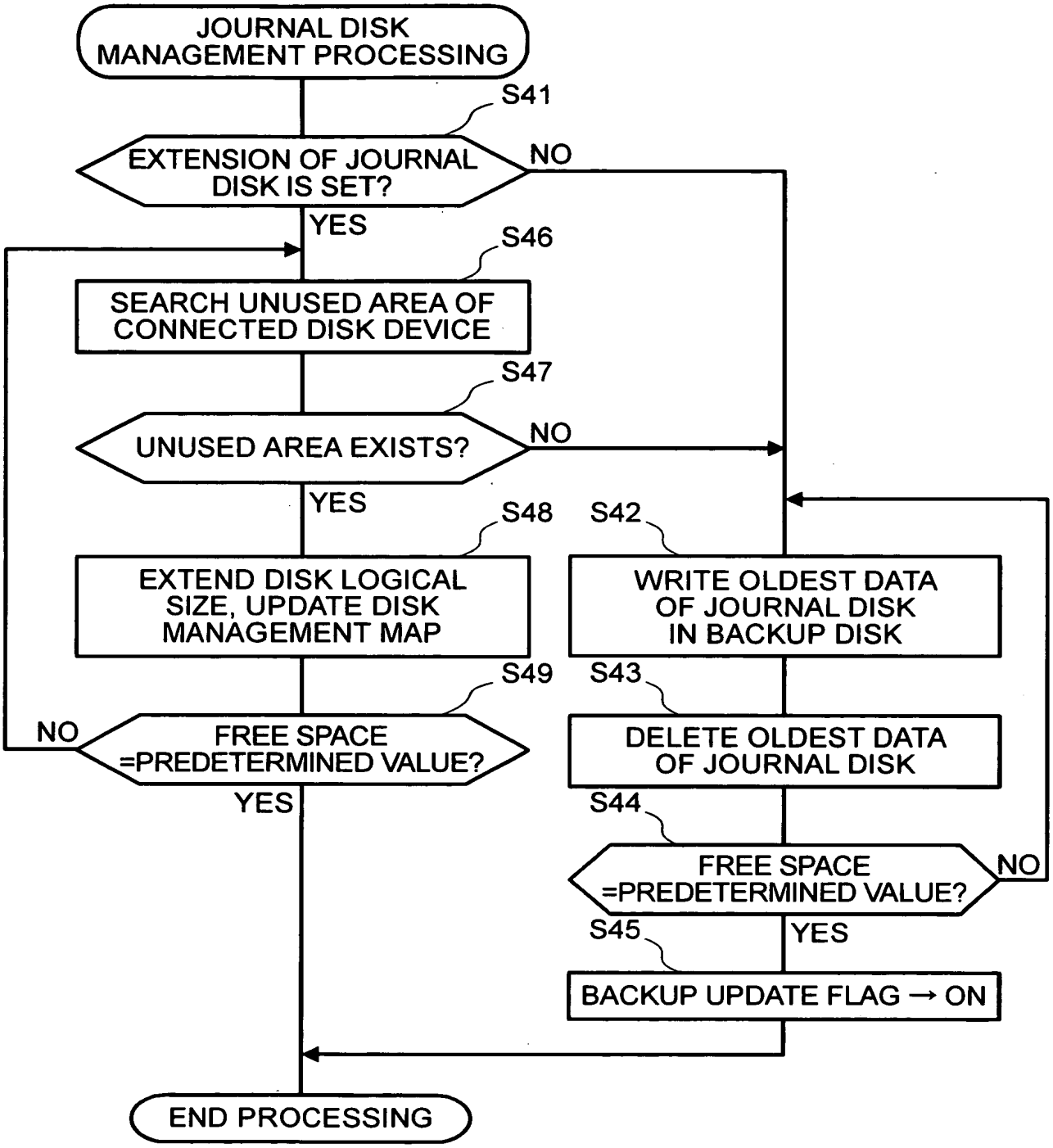

JOURNAL DISK MANAGEMENT PROCESSING
S41
EXTENSION OF JOURNAL DISK IS SET?
NO
YES
S46
SEARCH UNUSED AREA OF CONNECTED DISK DEVICE
S47
UNUSED AREA EXISTS?
NO
YES
S48
EXTEND DISK LOGICAL SIZE, UPDATE DISK MANAGEMENT MAP
S49
NO
FREE SPACE =PREDETERMINED VALUE?
YES
S42
WRITE OLDEST DATA OF JOURNAL DISK IN BACKUP DISK
S43
DELETE OLDEST DATA OF JOURNAL DISK
S44
FREE SPACE =PREDETERMINED VALUE?
NO
YES
S45
BACKUP UPDATE FLAG → ON
END PROCESSING

FIG.7

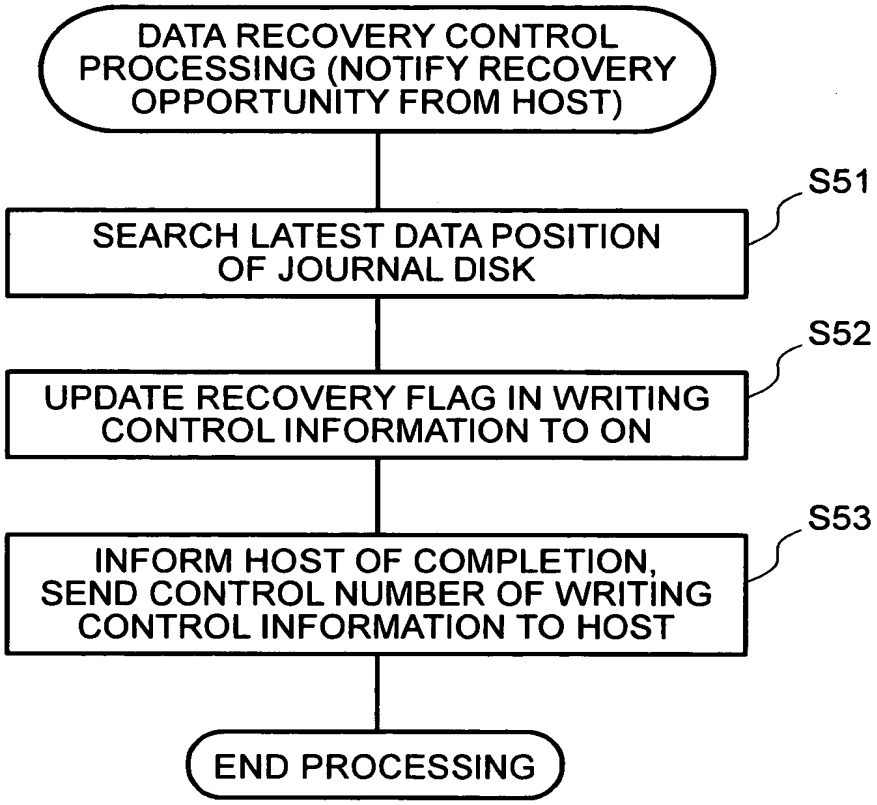

DATA RECOVERY CONTROL PROCESSING (NOTIFY RECOVERY OPPORTUNITY FROM HOST)
S51
SEARCH LATEST DATA POSITION OF JOURNAL DISK
S52
UPDATE RECOVERY FLAG IN WRITING CONTROL INFORMATION TO ON
S53
INFORM HOST OF COMPLETION, SEND CONTROL NUMBER OF WRITING CONTROL INFORMATION TO HOST
END PROCESSING

FIG.8

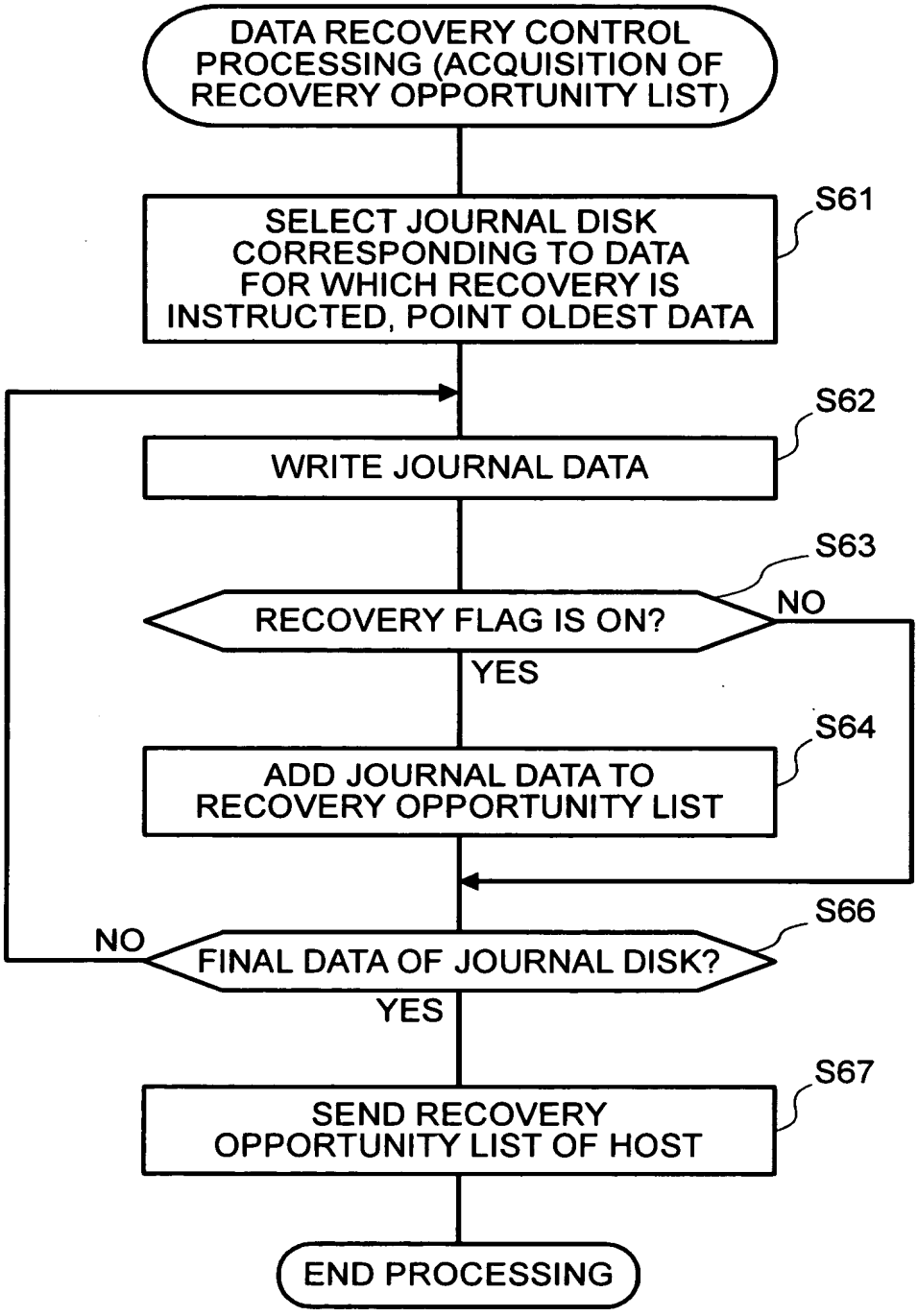

DATA RECOVERY CONTROL PROCESSING (ACQUISITION OF RECOVERY OPPORTUNITY LIST)
SELECT JOURNAL DISK CORRESPONDING TO DATA FOR WHICH RECOVERY IS INSTRUCTED, POINT OLDEST DATA
S61
WRITE JOURNAL DATA
S62
RECOVERY FLAG IS ON?
S63
NO
YES
ADD JOURNAL DATA TO RECOVERY OPPORTUNITY LIST
S64
FINAL DATA OF JOURNAL DISK?
S66
NO
YES
SEND RECOVERY OPPORTUNITY LIST OF HOST
S67
END PROCESSING

FIG.9

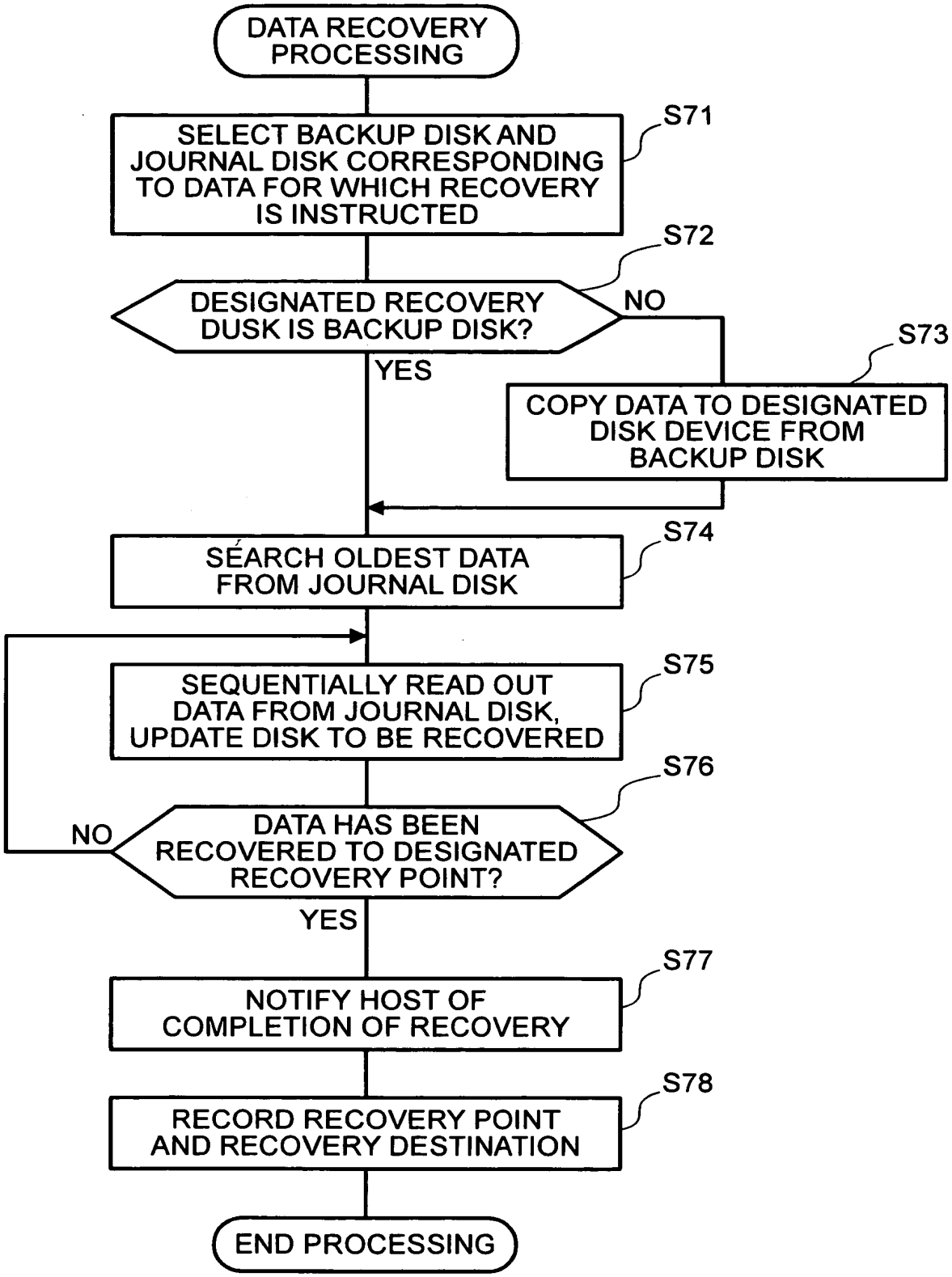
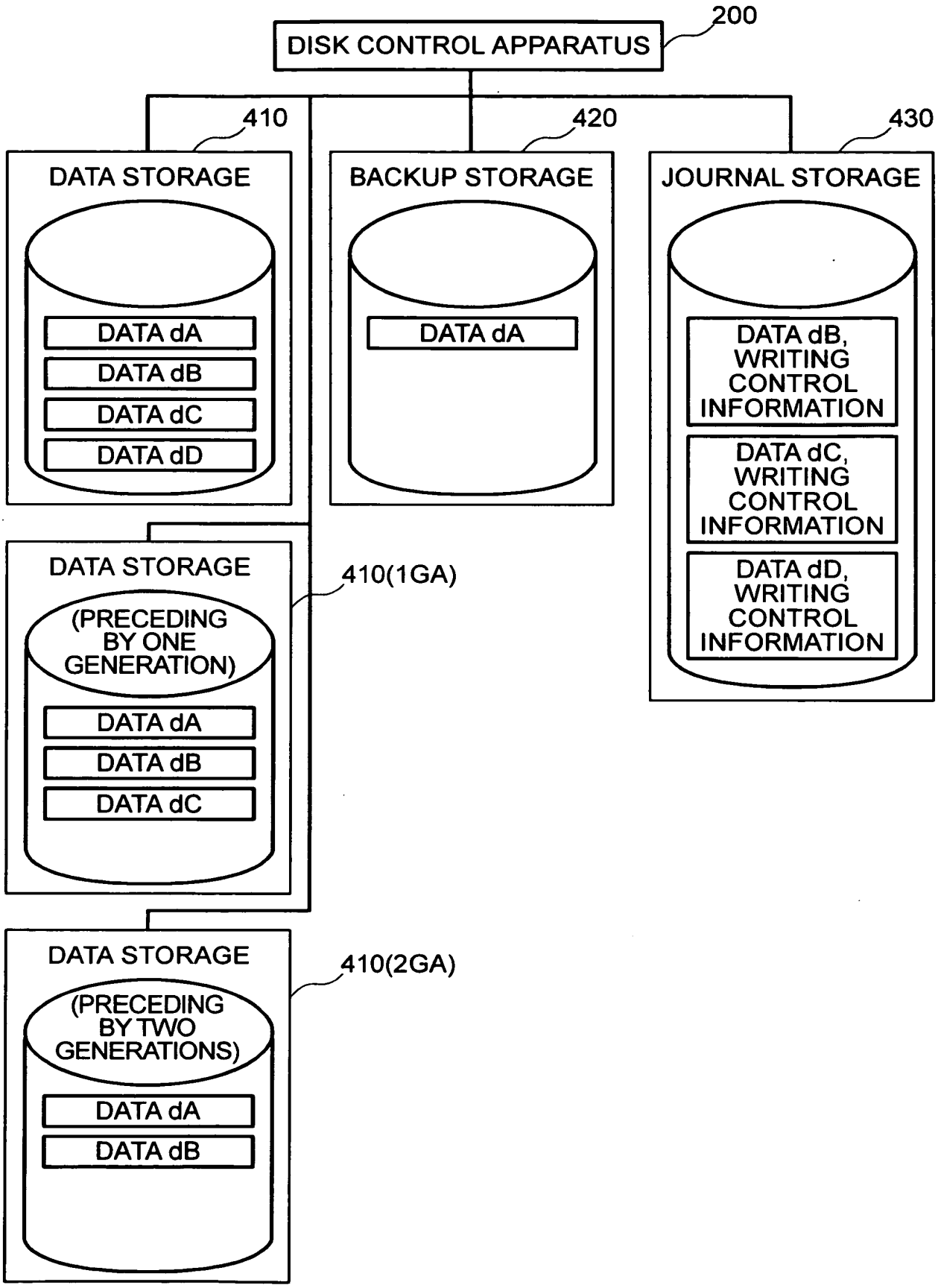

DATA RECOVERY PROCESSING
SELECT BACKUP DISK AND JOURNAL DISK CORRESPONDING TO DATA FOR WHICH RECOVERY IS INSTRUCTED
S71
DESIGNATED RECOVERY DUSK IS BACKUP DISK?
S72
NO
YES
COPY DATA TO DESIGNATED DISK DEVICE FROM BACKUP DISK
S73
SÉARCH OLDEST DATA FROM JOURNAL DISK
S74
SEQUENTIALLY READ OUT DATA FROM JOURNAL DISK, UPDATE DISK TO BE RECOVERED
S75
DATA HAS BEEN RECOVERED TO DESIGNATED RECOVERY POINT?
S76
NO
YES
NOTIFY HOST OF COMPLETION OF RECOVERY
S77
RECORD RECOVERY POINT AND RECOVERY DESTINATION
S78
END PROCESSING

FIG.10


200
DISK CONTROL APPARATUS
410
420
430
DATA STORAGE
BACKUP STORAGE
JOURNAL STORAGE
DATA dA
DATA dB
DATA dC
DATA dD
DATA dA
DATA dB, WRITING CONTROL INFORMATION
DATA dC, WRITING CONTROL INFORMATION
DATA dD, WRITING CONTROL INFORMATION
DATA STORAGE
410(1GA)
(PRECEDING BY ONE GENERATION)
DATA dA
DATA dB
DATA dC
DATA STORAGE
410(2GA)
(PRECEDING BY TWO GENERATIONS)
DATA dA
DATA dB